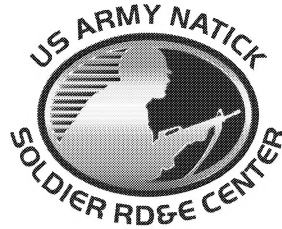TECHNICAL REPORT
NATICK/TR-08/020

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USER EVALUATION OF A SOLDIER FLEXIBLE DISPLAY PERSONAL DIGITAL ASSISTANT

by
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Human Research and Engineering Directorate
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14. ABSTRACT

The U.S. Army Natick Soldier Research, Development and Engineering Center and the U.S. Army Research Laboratory, Human Research and Engineering Directorate, Aberdeen Proving Ground, MD, conducted an evaluation of a Soldier Flexible Display Personal Digital Assistant (Soldier Flex PDA) during the Future Force Warrior (FFW) On-The-Move evaluation event at FT Dix, NJ. The Soldier Flex Display is an integrated flexible display technology demonstrator from the U.S. Army Flexible Display Center at Arizona State University. Six infantry Soldiers participated in a human factors evaluation of the physical design and readability of the Flex PDA. The PDA is being developed for displaying maps, blue force tracking information, memory joggers and transmission of short text messages to coordinate mission planning during combat operations. The Soldier viewed the PDA indoors and outdoors before providing their judgments on form, fit, and function of the device. Soldiers completed user questionnaires and participated in a focus group discussion to provide feedback for design improvements.

15. SUBJECT TERMS

SURVEYS   USER NEEDS   SPECIFICATIONS   QUESTIONNAIRES
PDA(PERSONAL DIGITAL ASSISTANT)   RATING   READABILITY   DESIGN CRITERIA
ARMY PERSONNEL   INFORMATION RETRIEVAL   TRACKING   FOCUS GROUP
DISPLAY SYSTEMS   DISMOUNTED SOLDIER   FLEXIBLE MATERIALS   HANDHELD
DATA DISPLAYS   FLEXIBLE DISPLAYS   INFANTRY PERSONNEL   HUMAN FACTORS ENGINEERING

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

ACKNOWLEDGEMENTS

User Evaluation of a
Soldier Flexible Display Personal Digital Assistant

1.0 EXECUTIVE SUMMARY

The U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) and U.S. Army Research Laboratory, Human Research and Engineering Directorate (ARL, HRED) conducted an evaluation of a Soldier Flexible Display Personal Digital Assistant (Soldier Flex PDA) during the July 2007 Future Force Warrior (FFW) On-The-Move (OTM) evaluation event at Ft. Dix, NJ. The Soldier Flex PDA is an integrated flexible display technology demonstrator from the U.S. Army Flexible Display Center at Arizona State University. The system is designed to be a rugged, low-power information device for the Soldier.

Six infantry Soldiers from the Ft. Benning Experimentation Force (EXFOR) participated in a human factors evaluation of the mechanical design and readability of the Flex PDA. The PDA is designed to run soldier-to-soldier communications software displaying maps, blue force tracking information, memory joggers and for the transmission of short text messages to coordinate mission planning during combat operations. The Soldiers viewed the reflective display indoors and outdoors then provided their judgments on form, fit and function of the device. Soldiers completed user questionnaires and participated in a focus group discussion to provide feedback for design improvements.

The results show they were fairly positive about the physical design. They liked the size, weight and feel of the device which they rated as better than the FFW PDA. However, they thought the device should be thinner.

The men were enthusiastic about display resolution in dim and bright light. They were also positive about the control buttons both in size and feel and thought they could operate it one handed even with gloves. However, they were not sure about the design in terms of storing and retrieving during tactical movement. Since they did not actually operate it during a mission exercise and were not wearing or carrying all their gear including holding their weapon they may not have been able to fully consider and evaluate the design for this capability.

The Soldiers clearly did not like the prospect of using the detachable stylus and almost universally recommended to get rid of it. If they had to use the touch screen they would prefer to operate it with their fingers. Since they may use their weapons either right or left handed, they will need a device that can be operated with either hand. The results of this user evaluation are consistent with previous Soldier-user surveys on hand-held display devices and offer recommendations for improvements of the current design.

1

2.0 INTRODUCTION

Meeting the military ruggedness requirements is one of the key problems in adopting new hand-held technologies (such as PDAs, pocket PCs, cell phones) for use by infantry soldiers. Current military PDAs have many negative attributes that prevent them from meeting Ground Soldier System (GSS) requirements. Protective casings and features usually make the device bulky and heavy. Their glass-based displays are fragile and difficult to read in direct sunlight. Furthermore, these devices consume large amounts of power that cannot be easily replenished in the field and have the potential to interfere with operational tempo, which is a critical component for mission success.

The Flexible Display Center (FDC) at Arizona State University is conducting engineering research to develop and fabricate a rugged, lightweight, low-power, sunlight readable "flexible" display built on plastic substrates. Unlike normal glass based technology, flexible displays can theoretically be made conformal and their packaging can be made thinner. The promise of this new technology opens up the possibility of smaller display form factors not possible from technology in the current commercial or military market. While the technology was not yet fully available to meet this smaller form factor in the prototype evaluated in this report, the expectation is that the capability will soon be available. Thus, as we explore user preferences and requirements, we direct attention to more optimal physical designs that the new technology is expected to offer.

3.0 OBJECTIVE

The U.S. Army's Natick Soldier Center (NSRDEC) and Human Research and Engineering Directorate (HRED) conducted a human factors evaluation of the initial Flex PDA demonstrator during the FFW OTM exercise at Ft. Dix, NJ. The objective was to evaluate and refine the physical forms for future display devices for a dismounted operator. This effort was primarily designed to evaluate such features as the size, shape, weight, and feel, as well as, the input/output buttons and the screen dimensions of the evolving designs to guide device specifications that will optimize Soldier task mission performance. The device software interface was not yet ready for a fuller functional evaluation of a simulated tactical operation.

4.0 METHODOLOGY

4.1   Description of Device Evaluated

The Flex PDA is a communication device that integrates an active matrix flexible display and power efficient electronics to create a rugged, low-power, ergonomic personal digital assistant (PDA) for a GSS warfighter. It incorporates a 4" diagonal QVGA flexible display, developed at the U.S. Army Flexible Display

Center at Arizona State University, with In-Hand Electronics™ power efficient hardware and software. The FDC display uses E-Ink™ electrophoretic display technology built on a flexible stainless steel substrate. This is a bi-stable display technology that only requires power when the image is updated. It uses reflective light, thus enabling readability in direct sunlight or with night-vision goggles while also being non-emissive on the battlefield. The PDA is designed to use C2MINCS (Command and Control Mobile Intelligent Net-centric Computer System) software to display maps, blue force tracking information, memory joggers and to send short text messages. The PDA connects to the FFW Basic Soldier System radio and battery via a cable. This cable plugs into the left side of the unit. It was designed to be operated with one hand by a right handed rifleman (so the user will operate it with his left hand). The PDA also includes: Bluetooth; touchscreen and stylus; input buttons; a rechargeable Li-Ion Polymer Battery; and runs the Linux 2.6 operating system.

It should be noted that C2MINCS was not fully functional at the time of this evaluation and thus was limited to using the buttons to page through static displays of text, maps and graphics. Also, since glass had to be used for the touch screen the PDA casing was made larger than originally planned to maintain some ruggedness for demonstration exercises. Figure 1 presents an image and the size dimensions of the Flex PDA.
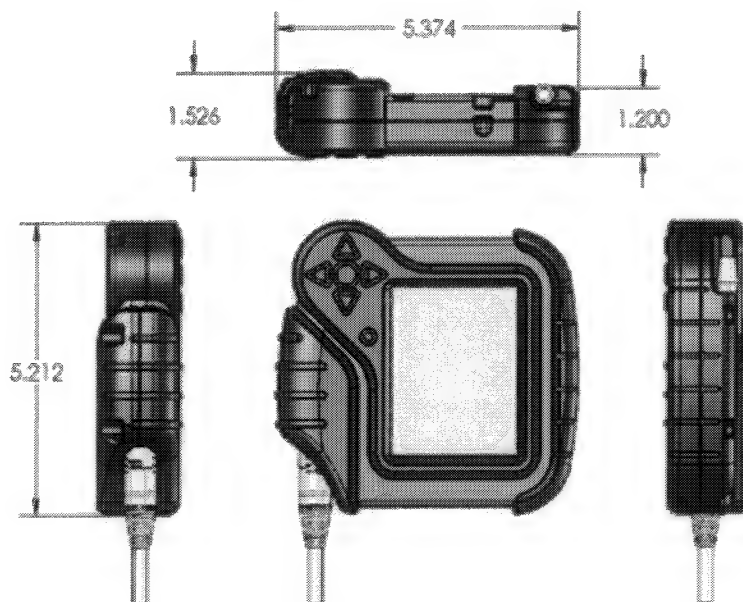

Figure 1. Soldier Flex PDA

4.2   Approach

A group of six Soldiers participating in the FFW OTM field exercise at Ft. Dix, NJ had the opportunity to evaluate the first iteration of the FFW Soldier Flex PDA. The Soldiers viewed the display images both indoors (fluorescent lighting)

and outside in bright sunlight. They were also asked to evaluate stowing and removing the Flex PDA into and from a pouch, and to simulate using the stylus on the touch-screen. All of these operations were performed both bare-handed and then wearing lightweight Nomex™ gloves being evaluated for FFW. After having an opportunity to interact with the Flex PDA each Soldier filled out a questionnaire and then engaged in a group discussion with researchers. The results and comments from that group discussion are presented below.

5.0 RESULTS

5.1 Background of Soldiers Surveyed

Table 1 presents the background data on the six Soldiers who participated in the evaluation. The participants were all trained infantrymen with 1.6 to 9 years of military experience (average: 4.4 years). Three of the men indicated they were Team Leaders (TLs), however, based on rank, it is believed that all four E-5's are currently serving as TLs. Their ages ranged from 19 to 31 years (average 24.7 years). They were currently being trained on the FFW system and all had at least some orientation or experience with the Tripod Data Systems PDA (TDS RECON) prior to evaluating the FDC Soldier Flex PDA Demonstrator.

Table 1. Background of Soldiers Surveyed

FlexDisplay Questionnaire	Ft. Dix OTM 17 July 2007					
ID No.	1	2	3	4	5	6
Background						
Age	30	31	19	23	23	22
Rank	E-5	E-5	E-3	E-5	E-5	E-4
Yrs Mil	4	9	1.5	4	5	3
MOS	11B	11B	11B	11B	11B	11B
Team Position	TL	blank	blank	TL	TL	blank
Gender	M	M	M	M	M	M
Glasses	No	Yes	No	No	No	Yes
Handed	L	R	R	R	R	R
Wpn Hand	R	R	R	R	L	R
Color Blind?	No	No	No	R/G	No	No
Frequency use small screens	daily	daily	daily	daily	daily	weekly
Play games how many times	few	always	many	many	rarely	rarely
Experience FFW PDA @ OTM	some	moderate	oriented	extensive	moderate	oriented
Military experience with any other PDA	none	moderate	oriented	moderate	extensive	oriented

All Soldiers were right handed except one; however, it should be noted that two of the Soldiers use their opposite hand to shoot. Some reported that they sometimes operate their weapons left handed. (*Reviewer's note: Soldiers were referring to ambidextrous firing of the rifle or carbine. This is especially true when they are conducting close combat operations. Soldiers are trained to follow the wall, body, weapon technique during urban operations, so this often leads to the Soldier shooting left or right handed. Crew served weapons can be fired with either hand, but the Soldier will normally not transition between the two during the mission.*)

Almost all respondents said they use some form of display routinely (e.g., cell phone) on a personal basis and thus are accustomed to using handheld displays for communication and/or for entertainment.

5.2   Questionnaire Results

After the Soldiers had an opportunity to examine and test the device they were asked to complete the rating questionnaire (see attachment). The questionnaire asked them to qualitatively rate the size, shape, weight and feel (e.g., balance) of the Flex PDA while both holding and operating it. They were also asked to evaluate the ease of use with one and two hands and the input-output features (control buttons) of the device in terms of operating with and without gloves. They rated the display readability and clarity individually for text, images, and maps. In addition, they were asked to consider the overall design in terms of stowing and removing the device while on the move and while wearing their full gear and holding their weapon.

Figure 2 shows the ratings on the size dimensions (width, height, depth) of the device. One Soldier considered the width and height Excellent while the remaining five rated these as Good. There was less agreement on the depth (thickness). One said it was Not Good, three said So-So, one Good and one Excellent. Four Soldiers wrote comments recommending that it be made thinner for ease of handling.
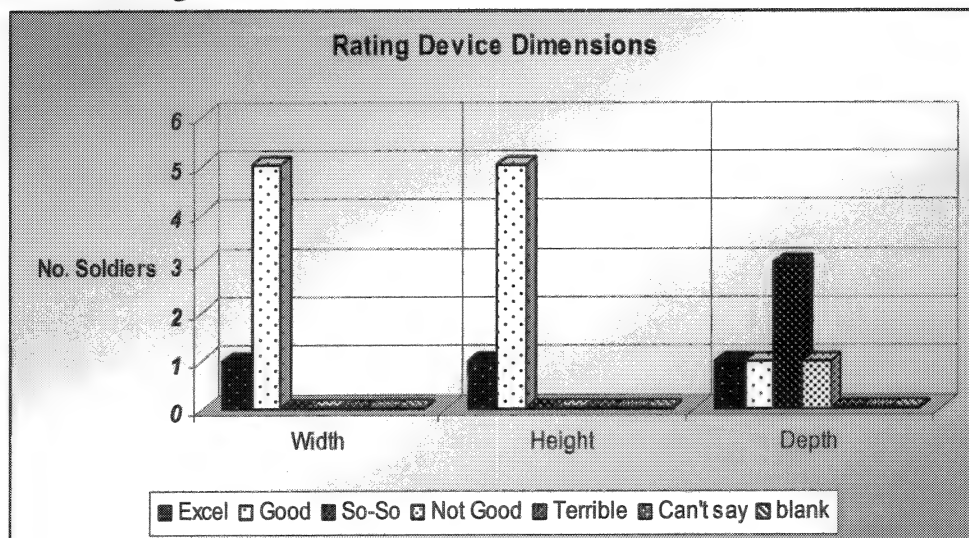
Figure 2. Rating Device Dimensions

Figure 3 presents the ratings for shape. Shape was considered in terms of holding, operating, stowing, and retrieving. The Soldiers gave high ratings for holding and operating (four Good, two Excellent) but gave lower ratings for storage and retrieval (one Not Good, two So-So, and three Good).

Ratings for the feel of weight in hand and the feel of weight in pocket as well as the sense of balance were generally rated Good to Excellent (Figures 4 and 5).

Written comments basically indicated they liked the weight and said they liked the balance and feel. One Soldier said we always want these to be lighter.
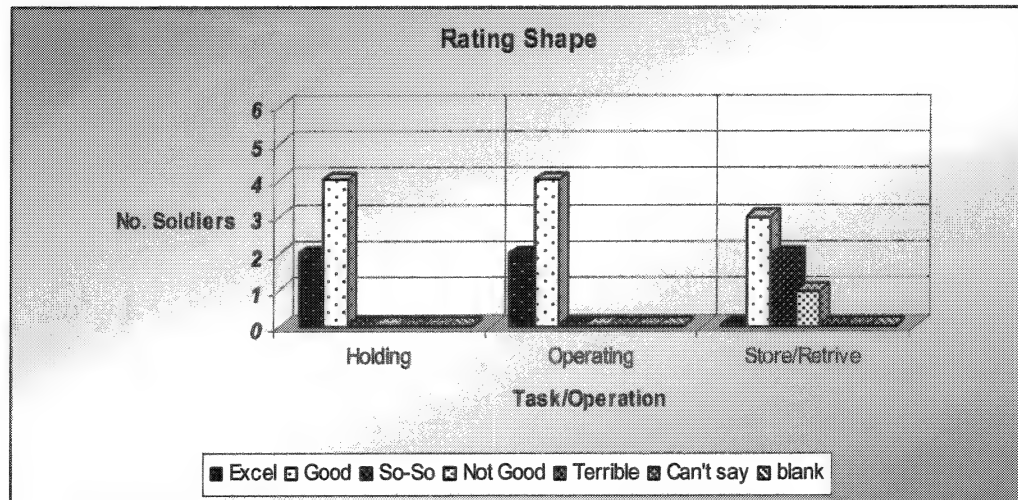
Figure 3. Rating Shape
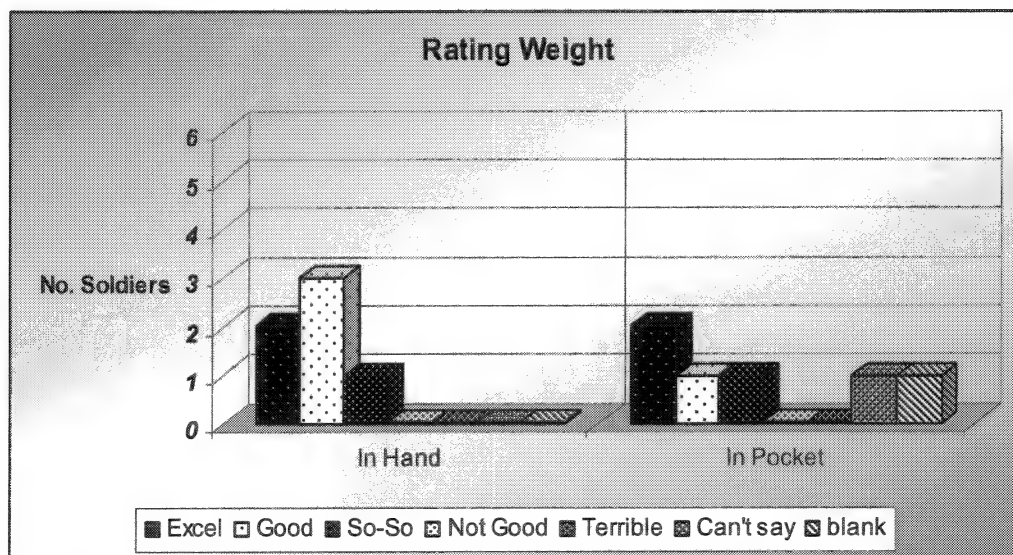
Figure 4. Rating of Weight
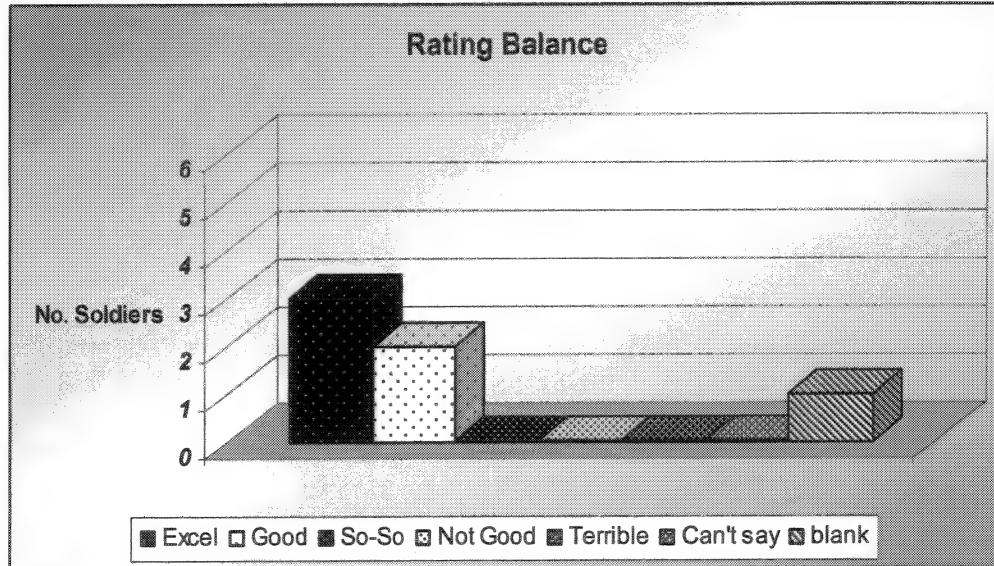
Figure 5. Rating of Balance

Figures 6 shows the ratings for the screen size considered for text, maps, photos and charts. Almost all the ratings were either Good or Excellent. One Soldier rated maps and charts as So-So. Comments suggest there was some reservation about maps because the demo map on the display was dark both inside and outside the building. Some thought the size of the screen relative to the device should be larger, i.e., should fill the space of the device.
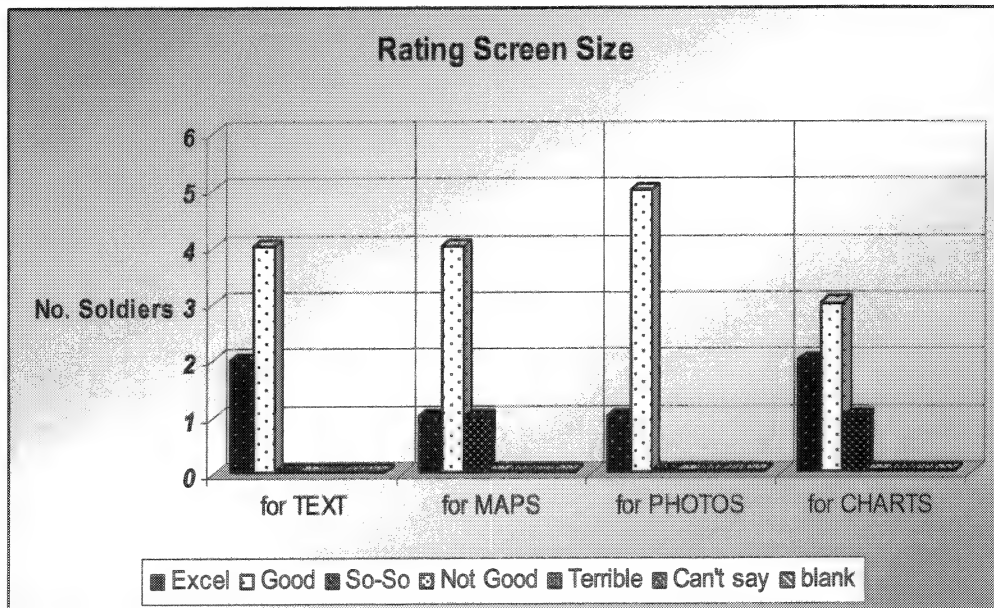
Figure 6. Rating Screen Size

The Soldiers rated the placement and orientation of the screen on the device as Good or Excellent (Figure 7) and liked the option of either portrait or landscape orientations.

Rating Screen Position/Orientation
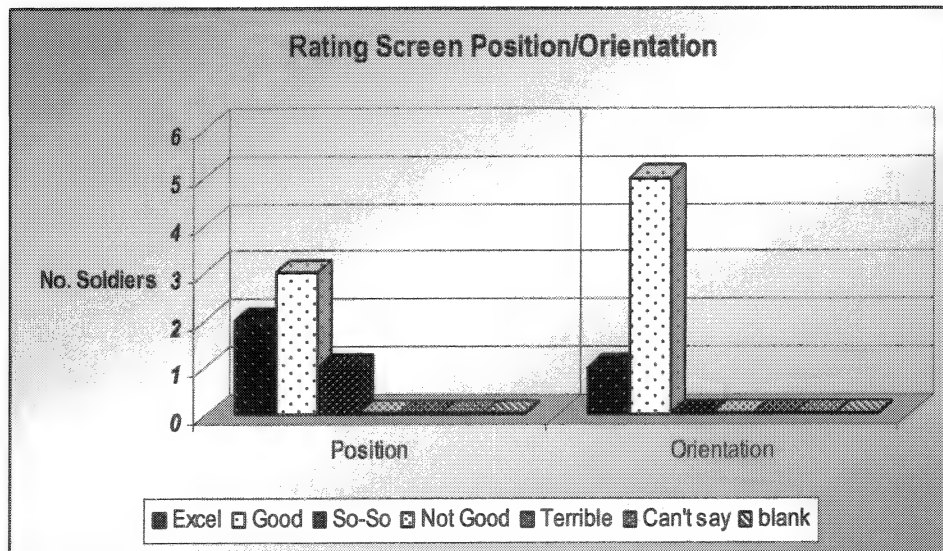
Figure 7. Rating Screen Position and Orientation

Figure 8 presents the ratings for the overall physical characteristics (size, shape, weight and balance) for operating, storing, and placement on arm and vest, and using it on the move. High ratings were given for simply operating the device (five Excellent, one Good) while the ratings were mixed for storing. Comments suggest there was uncertainty about where to stow the device, so some design changes might be necessary for improving stowing and retrieving more efficiently. Speed of these operations is also dependent on shape and size. Ratings for placements were relatively negative. The device was not considered to be well designed for placement on the arm. Some also felt there is little room left on the vest for storing. Two of the Soldiers considered the front or the side of the leg as possible areas for storage and even considered the design shape (lip on base) as good feature for easy removal from these positions.
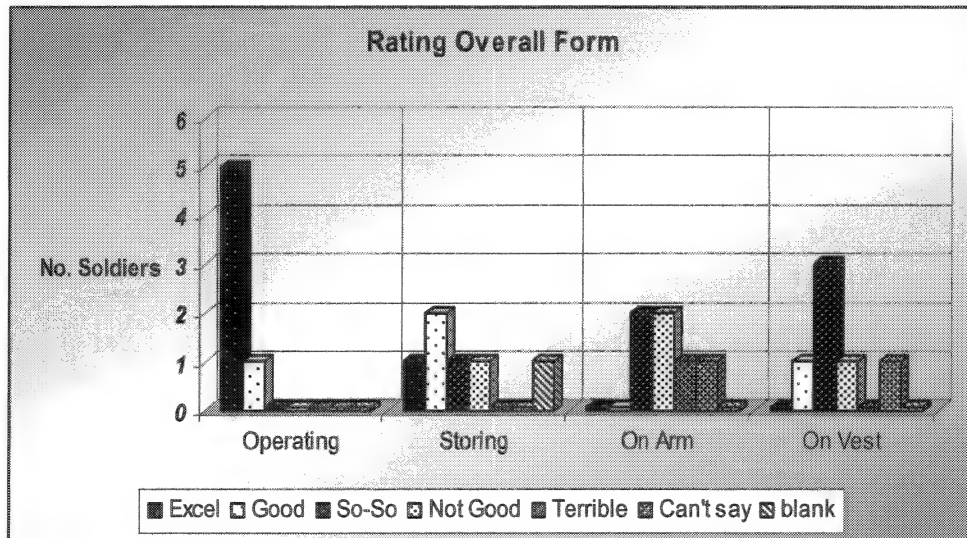
Figure 8. Rating Overall Form

Soldiers were asked to rate the ease of use with one and two hands. Figure 9 shows the ratings to be fairly positive about using with either one or two hands. One Soldier was negative (Not Good) for either, but it was generally considered easier to use with two hands and workable with one hand.
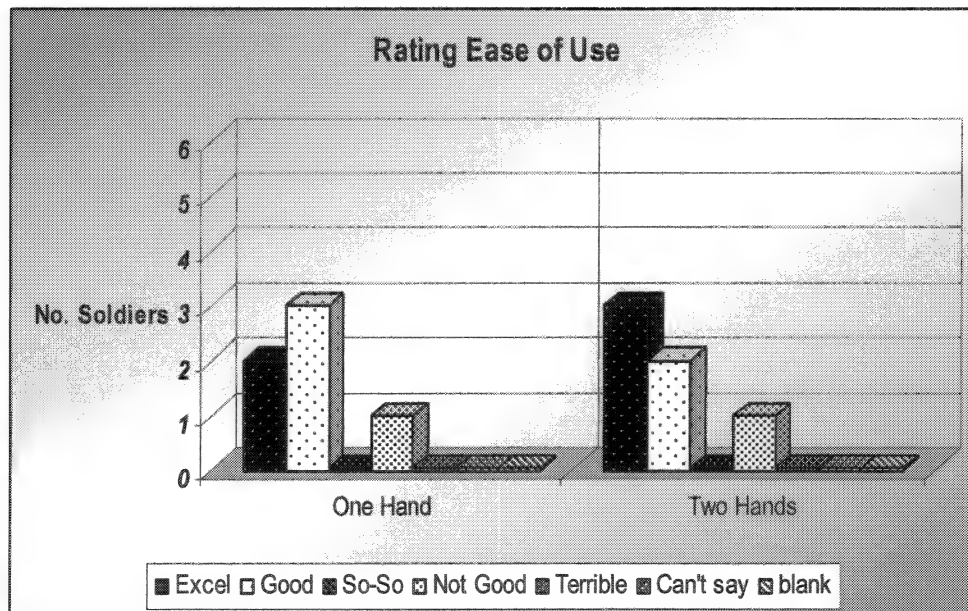
Figure 9. Rating Ease of Use

Soldiers were asked to evaluate the arrangement of buttons and controls. Figure 10 presents the ratings for buttons for on-off, menu control, cursor control, the stylus for the touch screen, screen orientation and the reset button. Some of these features were not discovered until the question was posed. They rated these after being shown how they work.   These features were rated positive with

9

the exception of the stylus. Comments suggest they do not like having to use the stylus. See the interview section for further discussion.
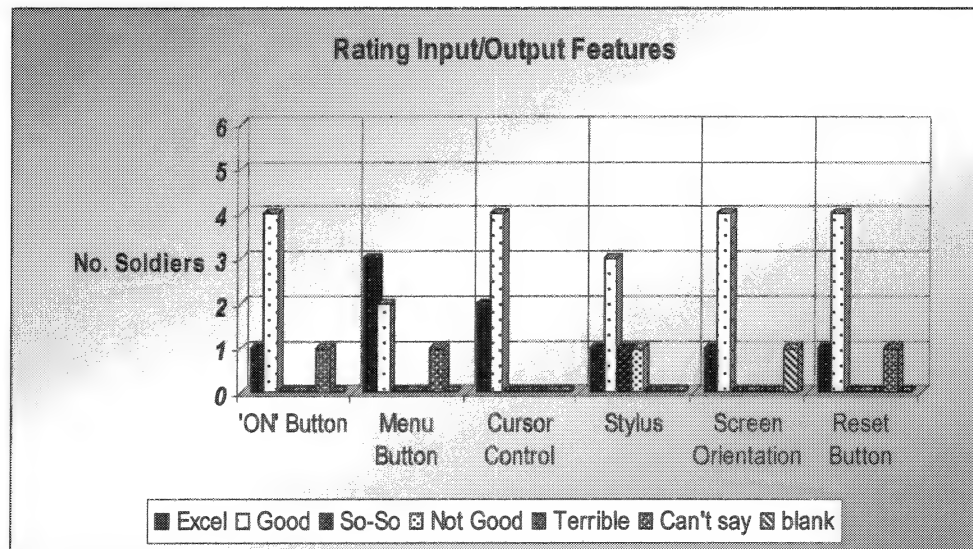
Figure 10. Rating the Input/Output Features

Figures 11 and 12 show the ratings for reading clarity of text and maps in dim and bright light. They were unable to rate readability under night conditions. The ratings were very high for text in both dim and bright light. Ratings for map clarity were mixed in part due to poor images.
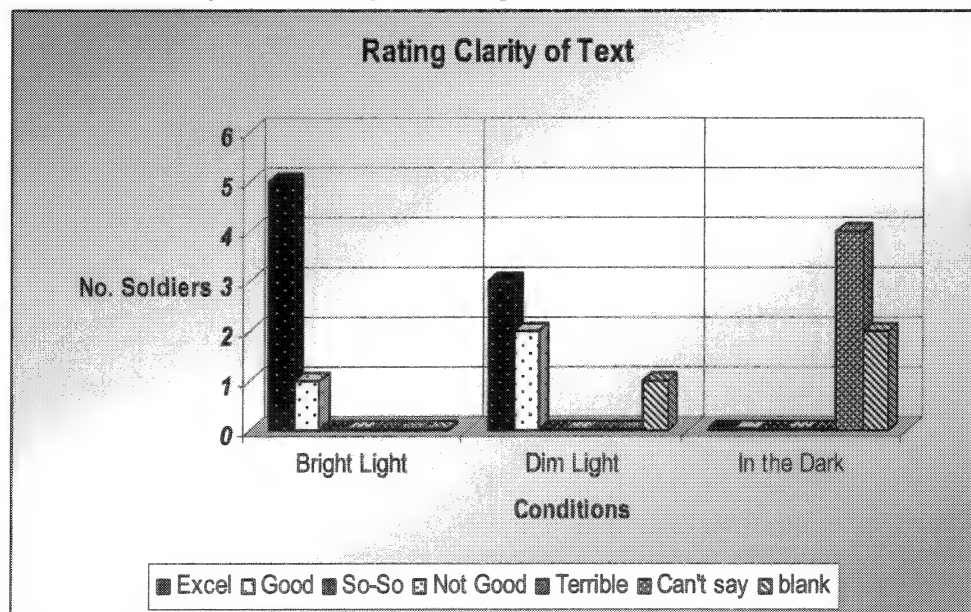
Figure 11. Rating of Clarity of Text
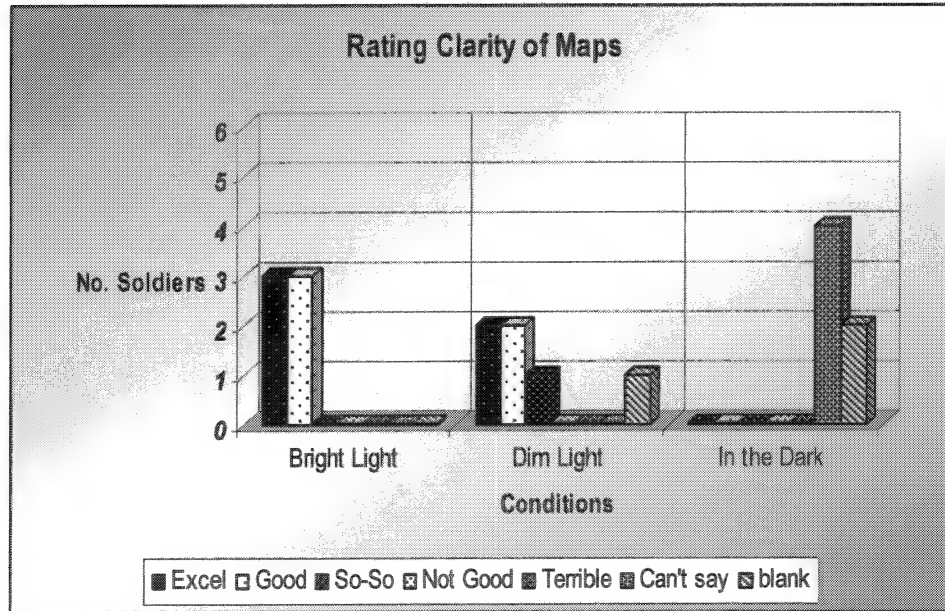
Figure 12. Rating Clarity of Maps.

Soldiers were finally asked their overall rating of the device. Figure 13 presents these ratings. Three Soldiers rated it Excellent, two rated it Good and one rated it So-So.
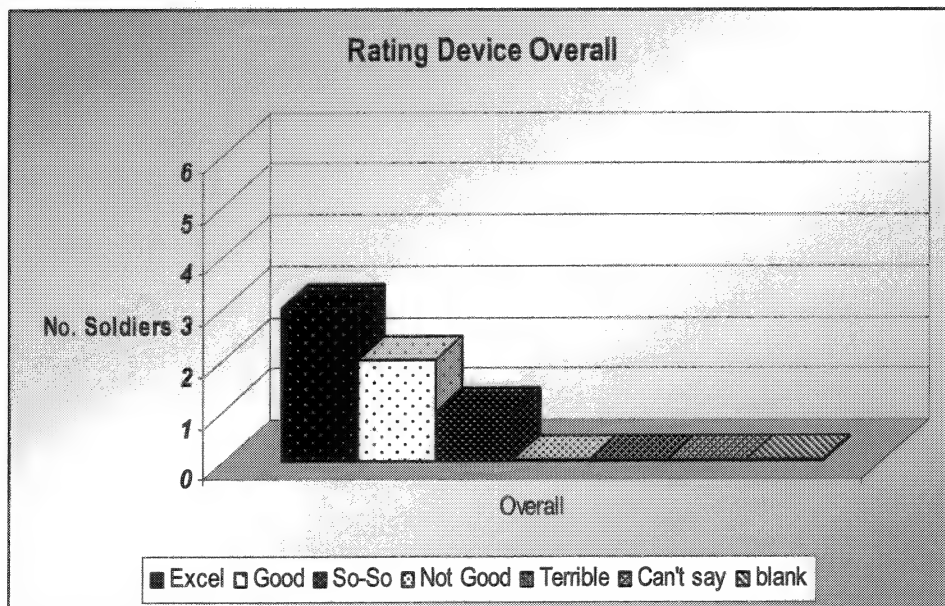
Figure 13. Rating of Device Overall

5.3   Summary of Written Comments.

Written comments and recommendations from the questionnaire are summarized below:

1. Thinner is better.
2. If it were easier to store in pocket and remove it definitely would be less of a hassle.
3. It was easy to hold and work.
4. Would like to actually try with C2MINCS software running and then answer these questions again.
5. Landscape provides better picture. Landscape & portrait options would be useful.
6. The screen should fill the device more (be larger relative to device size).
7. Attaching to arm means losing one handed capability. Too big for arm.
8. Make so it can be worked easily with one hand. Can't take hands off weapon.
9. Should be useable with either hand.
10. Need to evaluate with working software.
11. Get rid of the pen (stylus). If touch screen, then make it work with fingers.
12. Make a pull down key-pad like cell phone for text & data entry.
13. Must have easy access to menu and quick and easy access from pouch.
14. Overall, better than anything seen yet. Would take it if it were available.

The last item (#13) on the main questionnaire asked them to rate the Flex PDA relative to a series of PDAs pictured on the last page. Due to the confusion and/or the wording and layout of the question the responses given were not consistent or easy to interpret. Therefore, the data on this item were dropped from the analysis.

5.4   Group Interview Comments and Observations

The following notes were taken during the group discussion that followed the completion of the individual questionnaire. The Soldiers were asked to make additional comments or clarify points from the questionnaire. They were asked to consider using the device on the move and where they might store it when not in use. And finally, they were asked to compare the Flex PDA to the TDS RECON PDA.

- One Soldier stated that he would prefer to stow the PDA in a pouch on the front of his thigh rather than around the waist because there are already too many other items located on the vest making it difficult enough to fit in vehicles as it is. He didn't feel that placing it on the thigh would interfere with movement.

- The above Soldier also suggested orienting the plug for the radio perpendicular to its current location (along bottom instead of along side), so that the cord would come straight up out of the pouch when the PDA was stowed, reducing the chance of snagging it on something.

- The same Soldier felt that only about 1/3 of all Soldiers need something like the TDS RECON or Flex PDA. He commented that he didn't want to worry about his group looking down at displays when they were supposed to be focused on another task like conducting security. Several of the Soldiers agreed that it was really the Team Leaders who needed the radio capability that the PDA was tethered to.

- Several of the Soldiers mentioned that they would not want the display located on their arm, if it meant they had to use their weapon hand to operate it. One-handed operation is very important.

- One Soldier commented that he would like the display to be in color.

- At times the group seemed to feel that the general form factor was fine as is and that they would be happy to take it over the TDS RECON provided it offered similar functionality.

- The group also commented that it did not really matter if the Flex PDA was tethered (via radio cable) or wireless because they would still have to tie it down somehow. However, they all agreed that they wanted to have some flexibility in where they could stow it.

- One Soldier stated that a retractable cord would be great, but only if it worked better than previous versions.

- Some felt the size of the Flex PDA was perfect. Some commented that they wouldn't want it thinner/lighter/smaller because then it might be more difficult to hold/operate, especially with gloves. However, they also later commented that making it more lightweight would be a good thing. (*Note: Obviously, they were still forming opinions about all this and it will take developmental testing and evaluation to help solidify their judgments*).

- The entire group agreed that they did not like the stylus and wanted an alternative method of entering text and interacting with the touch-screen. A slide out keyboard (like on some cell phones, Blackberry layout) and an onscreen keyboard were suggested. After some discussion, it appeared that for durability and ease of use the touch screen keyboard was a better option, but it was stressed that the "buttons" would have to be large enough for them to use their fingers on the touch-screen. No stylus.

- The group also agreed that they would like the screen to be as large as possible, but without increasing the overall size of the Flex PDA.

- Several Soldiers commented that the TDS RECON is slow to update information. They don't want to have to sit and stare at the screen while they wait for it to refresh. They often need the data faster. (*Note: This was a limitation of the OTM network requirement at the time. However, this could be a significant issue for application of flexible displays that potentially have slower refresh rates.*)

6.0   DISCUSSION AND RECOMMENDATIONS

The results show they were relatively positive about the physical design. The height and width were fine. They liked the size, weight and feel of the device, which they rated as better than the TDS RECON. However, they thought the device should be thinner. The men were enthusiastic about display contrast resolution in indoor lighting and outdoor bright sun light. Unfortunately, they were not able to evaluate the display in low light or nighttime conditions with or without night vision devices.

The Soldier were also positive about the control buttons both in size and feel and thought they could operate with one hand even with Nomex™ gloves. However, they were not sure about the design in terms of storing and retrieval during tactical movement. A couple of the Soldiers thought the design might be ok if the pouch or pocket for it was on the upper leg (mounted off to the side much like they carry their pistol). Since they did not actually try to operate it during a mission exercise, and were not wearing or carrying all their gear including holding their weapon, they may not have been able to fully consider and evaluate the design for this capability.

As in their written comments they clearly expressed dislike of the detachable stylus and almost universally recommended to get rid of it. If they had to use the touch screen they would prefer to operate it with their fingers. The virtual keys would need to be larger, so that they could use their fingers or thumbs. One Soldier recommended a pull-down key-pad as found on some cell phones. However, such movable or mechanical features potentially make the device less durable for field operations under adverse conditions (dust, dirt, moisture).

Since they may use their weapons either right or left handed, they said the device needs to be operable with either hand. It was noted that switching hands may be done on the move during tactical operations. This may be a problem with the asymmetric design (it was designed for left hand operation assuming they held their weapon in their right hand). Curiously, most of the Soldiers spent time holding the PDA sideways with the display being in the landscape mode because many of the images were presented in landscape mode. Holding it this

14

way they tended to treat it more like a one-handed symmetrical PDA. See figure 14 below.
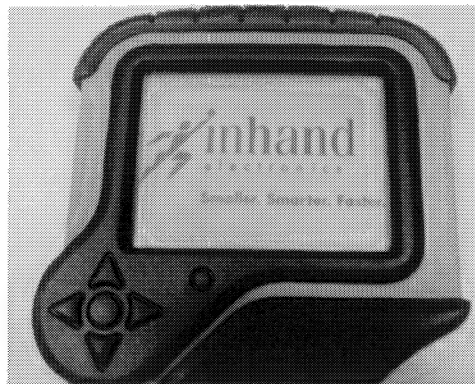

Figure 14. Flex PDA Demonstrator

They liked the idea of having the option of using the display in portrait or landscape modes. Again, the asymmetric design is less suited for such switching of operational modes.

Another aspect of the design that we often hear about in Soldier evaluations of hand-held displays is the relative size of the screen. Soldiers tend to want the display to fill the device space more. They want to see the display expanded nearer to the edges of the device. Admittedly, this would provide less room for the I/O control buttons. This suggests the design should be more or less like that shown in figure 15 below.
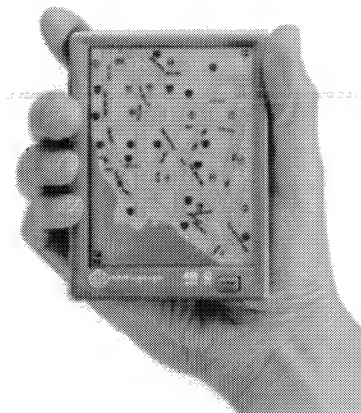

Figure 15. Example of a large Display-to-Device Ratio PDA

Perhaps with a slight extension of the length in the lower part of the device (making it longer) would provide a fuller screen while still allowing room for I/O buttons that can be operated with either hand. That change would make the design more like that shown in figure 16.
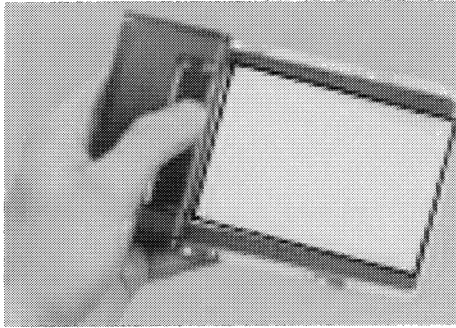
Figure 16. A One Handed/Ambidextrous PDA

In conclusion, the six Soldiers were generally positive about the Soldier Flex PDA and felt it was an improvement over the TDS RECON they were training with. They were particularly impressed by display readability in room and outdoor light conditions. They also liked the feel and balance of the display and the thumb operated I/O controls. They were less satisfied with the thickness of the device, the asymmetry (left-hand only) of the prototype and particularly the stylus. They would like to see a color display, a virtual or real (pull-out) key pad, a shape that can be operated with either hand, and the option of switching between landscape and portrait layouts. Unfortunately, they were unable to evaluate the device using the software they will be expected to use (C2MINCS). When the Soldier Flex PDA is more fully functional, additional evaluations with experienced Soldiers should be done to further identify strengths and weaknesses of the evolving design during mission exercises.

7.0 RECOMMENDED RESOURCES AND PRIOR STUDIES

Committee on Human Factors, *Tactical displays for soldiers: Human factors considerations.* National Academy Press, Washington, DC, 1997.

Elliott, L.R. and Heller, F.H. "Horizontal Fusion 2004: Soldier Evaluation of Warrior's Edge (WE) Technology." HRED Field Element, US Army Infantry Center, Ft. Benning, GA, October 2004.

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MIL-STD 1472. "Department of Defense Design Criteria Standard: Human Engineering." 23 August 1999.

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Appendix: User Background and Device Evaluation Questionnaires

Ft. Dix, NJ

Date: 17 July 2007

Please answer the following questions. Information used for data summary only. Name not retained and is used only during today's session and is not entered with background data in any data file record.

1. **First name & last initial:**_____ **Participant No.** _____

2. **Age:** _____

3. **Rank: O-** ____ **or E-** ____

4. **Years Military service? Years:** _____

5. **Primary MOS/Specialty (Title & No.)** _____

   _____

6. **Gender: Male : Female**

7. **Do you wear eyeglasses or contact lenses to read or view computer displays?**

   ____ Yes   ____ No

8. **Handedness: I'm predominantly:** ____ **Right Handed** ____ **Left Handed**

   Comment or clarification: _____

9. **Do you operate weapons or any other military equipment left-handed?**

   ____ Yes   ____ No

   Comment or clarification: _____

10. **Are you colorblind?** ____ Yes ____ No

    Type of colorblindness if known: _____

(continued over)

11. How frequently do you use devices with small display screens (e.g., cell phone, games, PDA)?   (check one):

_____ Daily, _____ Weekly, _____ Monthly, _____ Fewer times than Monthly

12. How much do you (or have you) played handheld electronic games? (check one)

_____ Not at all, _____ Rarely, _____ A few times, _____ Many times,

_____ Almost all the time

Comments or clarification: _____

13. How much experience do you have using the FFW PDA (aka the RECON)?

_____ a. No experience with the FFW PDA (RECON) at all.

_____ b. Have only had a brief orientation with the FFW PDA.

_____ c. I've used the FFW PDA a few times during OTM exercises.

_____ d. I've used the FFW PDA more than a few time during OTM.

_____ e. I've had considerable training and experience using the RECON.

14. Prior to this exercise, How much experience did you have using <u>any</u> PDA in operations?

_____ a. No training or experience using any PDA during military operations.

_____ b. Have only had a brief orientation with PDA for operations.

_____ c. I've used a PDA a few times during training exercises.

_____ d. I've used a PDA more than a few time during training exercises.

_____ e. I've had considerable training & field experience using a PDA.

User Questionnaire

Display Device: FDC-FFW Demonstrator .

User ID _____   Date: 17 July 2007

INSTRUCTIONS: Please evaluate the <u>device features</u> by **circling the phrase** that best describes your judgment of the listed feature. **Circling <u>?</u>** means you <u>can't say</u>.

1. Rate the device's **SIZE DIMENSIONS** ?

        a. Width   Excellent : Good : So-So : Not Good : Terrible : ?
        b. Height   Excellent : Good : So-So : Not Good : Terrible : ?
        c. Thickness (Depth)   Excellent : Good : So-So : Not Good : Terrible : ?

        Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

_____

2. Rate the device's **SHAPE**.

        a. for HOLDING: Excellent : Good : So-So : Not Good : Terrible : ?
        b. for OPERATING: Excellent : Good : So-So : Not Good : Terrible : ?
        c. for STORAGE & REMOVAL: Excellent : Good : So-So : Not Good : Terrible : ?

        Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

_____

3. Rate the **WEIGHT** of the device?

        a. Weight in the hand: Excellent : Good : So-So : Not Good : Terrible : ?
        b. Weight in pocket/pouch: Excellent : Good : So-So : Not Good : Terrible : ?

        Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

_____

4. Rate the **FEEL-BALANCE:**   Excellent : Good : So-So : Not Good : Terrible : ?

        Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

_____

5. Rate **DISPLAY SIZE**:

a. for TEXT (messages)	Excellent : Good : So-So : Not Good : Terrible : ?
b. for MAPS	Excellent : Good : So-So : Not Good : Terrible : ?
c. for PHOTOS	Excellent : Good : So-So : Not Good : Terrible : ?
d. for PLANNING CHARTS	Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why):   *(use oppose side for more comments)*

_____

6. Rate **DISPLAY PLACEMENT & ORIENTATION** on the device

a. Screen PLACEMENT is	Excellent : Good : So-So : Not Good : Terrible : ?
b. Screen ORIENTATION is	Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why):   *(use oppose side for more comments)*

_____

7. Rate <u>**overall**</u> **SIZE, SHAPE, WEIGHT, BALANCE** for:

a. Holding/Operating	Excellent : Good : So-So : Not Good : Terrible : ?
b. Storing/Retrieving	Excellent : Good : So-So : Not Good : Terrible : ?
c. Attaching to arm area	Excellent : Good : So-So : Not Good : Terrible : ?
d. Attaching to vest area	Excellent : Good : So-So : Not Good : Terrible : ?
e. Using ON THE MOVE	Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why):   *(use oppose side for more comments)*

_____

8. Rate **EASE OF USE** with

a. One hand	Excellent : Good : So-So : Not Good : Terrible : ?
b. Two hands	Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why):   *(use oppose side for more comments)*

_____

9. Rate **ARRANGEMENT** and **PLACEMENT** of

a. On-Off button:	Excellent : Good : So-So : Not Good : Terrible : ?
b. Menu activation button	Excellent : Good : So-So : Not Good : Terrible : ?
c. Cursor control buttons	Excellent : Good : So-So : Not Good : Terrible : ?
d. Touch screen pen	Excellent : Good : So-So : Not Good : Terrible : ?
e. Screen orientation	Excellent : Good : So-So : Not Good : Terrible : ?
f. Reset button	Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

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10. Rate display **QUALITY** (RESOLUTION-CLARITY)

a. Read-ability of **TEXT** in

1) Bright light	Excellent : Good : So-So : Not Good : Terrible : ?
2) Dim light	Excellent : Good : So-So : Not Good : Terrible : ?
3) In the dark	Excellent : Good : So-So : Not Good : Terrible : ?

b. Read-ability of **MAPS** in

1) Bright light	Excellent : Good : So-So : Not Good : Terrible : ?
2) Dim light	Excellent : Good : So-So : Not Good : Terrible : ?
3) In the dark	Excellent : Good : So-So : Not Good : Terrible : ?

c. View-ability of **PHOTOS** in

1) Bright light	Excellent : Good : So-So : Not Good : Terrible : ?
2) Dim light	Excellent : Good : So-So : Not Good : Terrible : ?
3) In the dark	Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

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11. Rate **OVERALL JUDGMENT** of the device

The overall design is   Excellent : Good : So-So : Not Good : Terrible : ?

Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

(continue to next page)

12. **RECOMMENDATIONS OR SUGGESTIONS** to improve the physical design and operating features of the device for your MOS or Specialty area?

13. **On attached sheet** are pictures of other display devices. Next to each heading below indicate **by placing the picture's letter (a., b. c. etc)** how each device, compares to the device you just evaluated:

List the pictured devices (by letter) that appear to be:

a. **BETTER*** than device evaluated _____

b. **SAME** as device evaluated: _____

c. **WORSE** than device evaluated: _____

*For your job-tasks

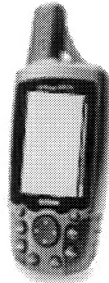Comments – Notes (If negative, explain why): *(use oppose side for more comments)*

_____

End of Questionnaire

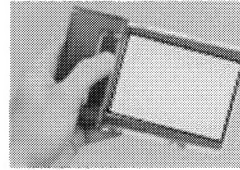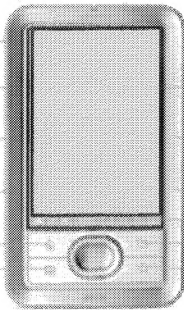Not to exact scale

Comparison Devices

A
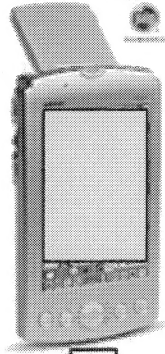
B

C

D

E

F
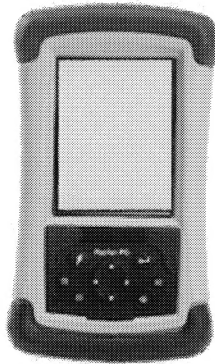
G
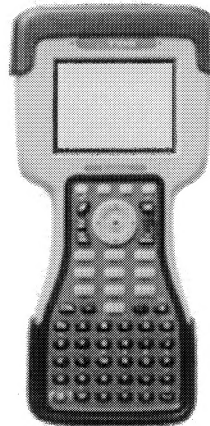
H
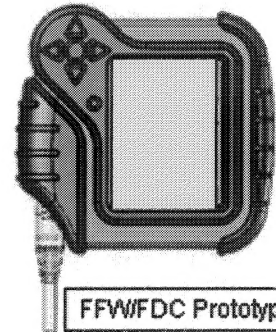
FFW/FDC Prototype

LIST OF ACRONYMS

ARL	Army Research Laboratory
C2MINCS	Command & Control Mobile Intelligent Net-centric Computer System
EXFOR	Experimentation Force
FDC	Flexible Display Center
FFW	Future Force Warrior
Flex PDA	Flexible Personal Digital Assistant
GSS	Ground Soldier System
HRED	Human Research and Engineering Directorate
NSRDEC	Natick Soldier Research, Development and Engineering Center
OTM	On-The-Move
QVGA	Quarter Video Graphics Array (320 x 240 pixels)
SEDD	Sensors Electronic Device Directorate, Army Research Lab.
TDS RECON	Name of PDA by Tripod Data Systems used by FFW